tractions of death. The latter always contain more red particles in their substance than those of cold blood, and are sooner deprived of their irritability, even though their relative temperature be preserved. It appears, also, that respiration in the former tribe is more essential to life than in the latter.

Various experiments are next mentioned on the substances which accelerate the cessation of irritability in muscles when applied to their naked fibrils, such as all narcotic vegetables, poisons, muriate of soda, the bile of animals, &c. Discharges of electricity, passed through muscles, destroy their irritability, but leave them apparently inflated with small bubbles of gas, owing, perhaps, to some combination which decomposes water. Workmen who are exposed to the contact of white lead, nitric acid, or quicksilver, frequently experience local spasms or partial palsy.

Lastly, some arguments are adduced which prove that a smaller quantity of blood flows through a muscle in the state of contraction than during its quiescent state; that when muscles are vigorously contracted, their sensibility to pain is nearly destroyed; and that the human muscles are susceptible of considerable changes, from extraordinary impressions on the mind, such as grief, fear, uncommon attention, mental derangement, &c.; in all which cases uncommon muscular exertions have been observed, which could not have been affected without the operation of those stimulants.

Sect. 6.—This section contains some conclusive remarks, chiefly on the effects of stimuli on the muscles, as they are distinguished into voluntary, involuntary, and mixed. For the classification of these agents here stated, we must refer the curious physiologist to the paper itself; having already, perhaps, trespassed too far upon the time that can well be spared for the abstract of this lecture.

Experiments for ascertaining how far Telescopes will enable us to determine very small Angles, and to distinguish the real from the spurious Diameters of celestial and terrestrial Objects: with an Application of the Result of these Experiments to a Series of Observations on the Nature and Magnitude of Mr. Harding's *lately discovered Star. By* William Herschel, *LL.D. F.R.S.* Read December 6, 1804. [*Phil. Trans.* 1805, *p.* 31.]

Dr. Herschel commences his paper by stating, that, being desirous of ascertaining the magnitude of the moving celestial body lately discovered by Mr. Harding, and intending, for that purpose, to make use of a ten-feet reflector, it appeared to him a desideratum highly worthy of investigation, to determine how small a diameter of an object might be seen with that instrument. He had, he says, in April 1774, determined a similar question relating to the natural eye; and found that a square area could not be distinguished from an equal circular one till the diameter of the latter came to subtend an angle of 2′ 17″; but, as he did not think it right to apply the same conclusions to a telescopic view of an object, he, in order to

determine the first-mentioned question, made a series of experiments, of which the following is a summary account.

Dr. Herschel's first experiment was made upon the heads of pins, the size of the largest of which was ·1375, and that of the smallest ·0425 of an inch. These pins were placed at the distance of 2407·85 inches from the centre of the object-mirror of the author's ten-feet telescope; the focal length of the mirror of which, on Arcturus, is 119·64 inches, but on the objects above mentioned 125·9.

Dr. Herschel soon found that none but the smallest of those objects could, at the distance at which they were placed, be of any use; and that an object of that size, namely, ·0425 of an inch, may be easily seen, in his telescope, to be a round body when the magnified angle under which it appears is $2' 18''\cdot9$, and that with a high power a part of it, subtending an angle of $0''\cdot364$, may be conveniently perceived.

In the second experiment, Dr. Herschel made use of globules of sealing-wax. These globules were of different sizes, from ·0466 to ·00763: and the result of the experiment was, that, with a globule so small as ·00763 of an inch of a substance not reflecting much light, the magnified angle must be between 4 and 5 minutes before we can perceive it to be round. But it also appears that a telescope, with a sufficient power, will show the disc of a faint object when the angle it subtends, at the naked eye, is no more than $0''\cdot653$.

The third experiment was made with globules of silver, formed by running the ends of very fine silver wires into the flame of a candle. The size of these globules was from ·03956 to ·00556, and the distance of these objects from the mirror of the telescope was increased to 2370·5 inches. By this experiment it was found that the telescope acted very well with a high power, and would show an object, subtending only $0''\cdot484$, so large, that it might be divided into quarters of its diameter.

The fourth experiment was made with globules of pitch, bees' wax, and brimstone. From the two first-mentioned substances, no satisfactory inference could be drawn; but when four globules of brimstone, the sizes of which were ·00962, ·009125, ·00475, ·002375, were viewed with a power of 522·7, the three first appeared round; the fourth was invisible till a dark blue paper was placed a few inches behind it. The angle it subtended was $0''\cdot207$.

The fifth experiment consisted in observing the globules of sealing-wax and those of silver at a distance still greater, namely, 9620·4 inches, with a power of 502: the smallest globules of the former substance were invisible at that distance; but all the silver globules except the smallest (which, having met with an accident, could not be examined,) appeared round.

The sixth experiment was made by fixing some of the silver globules on a post, and illuminating them, by holding a lantern against them: with a power of 522·7 they were all seen perfectly well, but the light thrown on them was not sufficient to allow of making angular experiments upon them.

Dr. Herschel then, in order to investigate the causes of the spurious diameters of celestial objects, relates some observations made upon several of the fixed stars, from which he deduces the following inferences:—

1. That the spurious diameters of the stars are larger than the real ones, which are too small to be seen.

2. That the spurious diameters are of different sizes; but that, under the same circumstances, their dimensions are of a permanent nature.

3. That the spurious diameters are differently coloured, and that these colours are permanent when circumstances are the same.

4. That these diameters are proportionally lessened by increasing the magnifying power, and increase when the power is lowered.

5. That the above-mentioned increase and decrease is not inversely as the increase and decrease of the magnifying power, but in a much less ratio.

6. That the magnifying power acts unequally on spurious diameters of different magnitudes; less on the large diameters, and more on the small ones.

7. That when the aperture of the telescope is lessened, it occasions an increase of the spurious diameters; and when increased, reduces them.

8. That this increase and decrease is not proportional to the diameters of the stars, but that an alteration in the aperture of the telescope acts more upon small spurious diameters and less upon large ones.

9. That stars which are extremely small lose their spurious diameters, and become nebulous.

10. That many causes will influence the apparent diameter of the spurious discs of the stars; but that, with a proper regard to those causes, the conclusion already drawn, that under the same circumstances their dimensions are permanent, still remains good.

A number of experiments then succeed on the spurious diameters of terrestrial objects. The first series of these were made by means of the silver globules already mentioned. The inferences drawn from them are similar to those drawn from the observations of celestial objects, except that the spurious discs of terrestrial objects, contrary to what happens with celestial ones, are smaller than the real discs, and that they are apt to be lost for want of proper illumination, but do not on that account change their magnitude.

Similar experiments were made with drops of quicksilver, the results of which differed so little from those of the experiments with globules of silver, as not to require any further description of them.

After two preparatory experiments, one with black and white circles, which showed that no material deception can take place in estimating by such circles, on account of their colour, and another, which showed that no difference in the apparent size of the globules was produced by a different mode of illuminating them in the microscope, Dr. Herschel proceeded to measure the spurious disc of one

of the globules. For this purpose, he viewed it with apertures of different dimensions and of different kinds. Some of them being of the usual annular opening or outside rim, from 6·5 to 8·8 inches, which reflected less than half the light of the mirror, produced a spurious disc less than ·18 in diameter; while the whole light of the mirror gave a disc of ·31: he thinks it fair to conclude, that it is not the quantity of light, but the part of the mirror from which it is reflected, that we are to look upon as the cause of the magnitude of the spurious discs of objects; and this, he says, points out an improved method of putting any terrestrial disc, that we suspect to be spurious, to the test: for the inside rays of a mirror will increase the diameter of those discs; but the outside rays alone will have a greater effect in reducing it, than when the inside rays are left to join with them.

Dr. Herschel then placed two other globules at a small distance from each other, without having previously measured either their size or the distance between them. Upon viewing them with a power of 522·7, they appeared in the shape of half-moons; he estimated the vacancy between the cusps to be one fourth the diameter of the largest; and found afterwards, on measuring the diameters and distance, that his estimation did not differ $\frac{1}{300}$th of an inch from the truth. In a second experiment the difference between the real and the estimated distance was still less.

In order to ascertain whether these half-moons were real or spurious, Dr. Herschel viewed them first with the inside rays of the mirror, then with the outside rays, and lastly, with the whole mirror open, but no alteration in the distance of the lunes could be perceived. He then divided the aperture of the mirror into two parts, one from 0 to 4·4 inches, the other from 4·4 to 8·8; and found, on measuring the spurious diameter of a globule, that with the inside rays it was ·40; with the whole mirror open it was ·31; and with the outside rays it was ·22.

From this, he says, we may conclude, that the diameters given by the inside rays, by all the mirror open, and by the outside rays, are in an arithmetical progression; and that the inside rays will nearly double the diameter given by the outside.

α Lyræ being then examined in the same manner, its spurious disc was found to be small with the outside rays; with the whole mirror open it was larger; and with the inside rays it was largest.

The double star *α* Geminorum was then viewed with a power of 410·5; with the outside rays they appeared unequal, and $1\frac{1}{4}$ diameter of the largest asunder; with the whole mirror open they were more unequal, and $1\frac{1}{2}$ diameter of the largest asunder; with the inside rays they were very unequal, and $1\frac{7}{8}$ of the largest asunder.

The foregoing experiments show, the author says, that if it had not been known that the apparent discs of the stars were spurious, the application of the improved criterion of the aperture would have discovered them to be so; and that, consequently, the same improvement is perfectly applicable to celestial objects.

Dr. Herschel, having made these preliminary experiments, proceeds to apply them to investigate the nature and magnitude of the star lately discovered by Mr. Harding. A regular series of observations on this star are detailed, beginning on the 29th of September, and ending on the 11th of October. Of these we must necessarily confine ourselves to mention merely the general result with the conclusions deduced by the author from the whole of the investigation. These conclusions are as follows:—

1. A ten-feet reflector will show the spurious or real discs of celestial and terrestrial objects, when their diameter is one fourth of a second; and in favourable circumstances that diameter may be divided, by estimation, into two or three parts.

2. A disc of the above diameter, whether spurious or real, to be seen as a round well-defined body, requires a magnifying power of 500 or 600, and must be sufficiently bright to bear that power.

3. A real disc of half a second in diameter will be so magnified by the above-mentioned power, that it may be easily distinguished from a spurious one of equal size, the latter not being affected by magnifying power in the same proportion as the former.

4. The different properties of the inside and outside rays of a mirror, with regard to the appearance of a disc, will show whether it is real or spurious, provided its diameter is more than one-fourth of a second.

5. When discs, either spurious or real, are less than one fourth of a second in diameter, they cannot be distinguished from each other, because the magnifying power is not sufficient to make them appear round and well defined.

6. The same kind of experiments are applicable to telescopes of different sorts and sizes, but will give a different result for the quantity here stated at one fourth of a second, being more when the instrument is less perfect, and less when it is more so.

The general results of Dr. Herschel's observations on Mr. Harding's newly discovered celestial body, to which the name of Juno has been given, are,—

1. That it is in every respect similar to those discovered by Mr. Piazzi and Dr. Olbers, so that Ceres, Pallas, and Juno, are certainly three individuals of the same species.

2. That these bodies (the last of which appears to be the smallest,) are incomparably smaller than any of the planets; for a telescope that will show a diameter of one fourth of a second, will not determine whether their discs are real or spurious, although a power of more than 600 has been applied to each of them.

3. That the criterion of the apertures of the mirror has, on account of the smallness of the object, been equally unsuccessful; every method that has been tried only proving their resemblance to small stars.

4. That the definition of the term asteroid, formerly given by Dr. Herschel, will equally express the nature of Juno, which, on account of its similar situation between Mars and Jupiter, and its departure from the general condition of planets, by the smallness of its

disc, and the great inclination and eccentricity of its orbit, may also be considered as a true asteroid.

Dr. Herschel concludes by observing, that the specific difference between planets and asteroids appears now, by the addition of a third individual of the latter species, to be more fully established; and that circumstance, he thinks, has added more to the ornament of our system, than the discovery of another planet could have done.

An Essay on the Cohesion of Fluids. By Thomas Young, *M.D. For. Sec. R.S.* Read December 20, 1804. [*Phil. Trans.* 1805, *p.* 65.]

Dr. Young's principal objects in this paper are to reduce the phenomena of the capillary action of fluids to the general law of an equable tension of their surfaces; to investigate the properties of the curves resulting from this law; to determine the magnitude of the apparent adhesion of solids to fluids, and the cohesion of moistened solids; and to show in what manner the law itself is probably derived from the fundamental properties of matter.

Dr. Young observes, that a fluid which is not capable of wetting a given solid, forms with it an angle of contact which is constant in all circumstances; that the curvature of the surface of a fluid, or the sum of the curvatures, where the curvature is double, is always proportional to the elevation or depression with respect to the general surface, and that the curve itself admits, in all cases, an approximate delineation by mechanical means, but is not always capable of being easily subjected to calculation. When, however, the curvature is simple, the direction of the surface, at any given height, admits a correct determination. Hence the elevation of a fluid in contact with a given surface, whether vertical, horizontal, or inclined, is deduced from its ascent between plates, or in a tube, of the same substance; and the result is shown to agree with experiments. Thus, taking $\frac{1}{25}$th of an inch for the diameter of a tube, in which water rises to the height of an inch, it is inferred that the apparent adhesion of water, to a square inch of any horizontal surface capable of being wetted by it, must be $50\frac{1}{2}$ grains, which is only half a grain more than the result of Taylor's experiments. The adhesion of alcohol, and of sulphuric acid, as measured by Achard, are also found to agree with the ascent of those fluids in capillary tubes. Lord Charles Cavendish's table of the depression of mercury in barometer tubes, is compared with the same principles by means of diagrams constructed for each particular case; and the apparent adhesion of the surface of mercury to glass, as well as the depth of a portion of mercury spread on a plate of glass, is deduced from these measures, and is shown to agree with experiments. The observations of Morveau, on the attraction of the different metals to mercury, are also discussed; and some remarks are made on the magnitude of drops of various substances.

The hydrostatic actions of these elevations and depressions of fluids are such as to afford a ready explanation of the attractions